Department for Environment Food & Rural Affairs

Applying Earth Observations to Reduce Uncertainties in Emission Inventories

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NATURAL ENVIRONMENT RESEARCH COUNCIL

UK NH_3 emissions estimated with Earth observations

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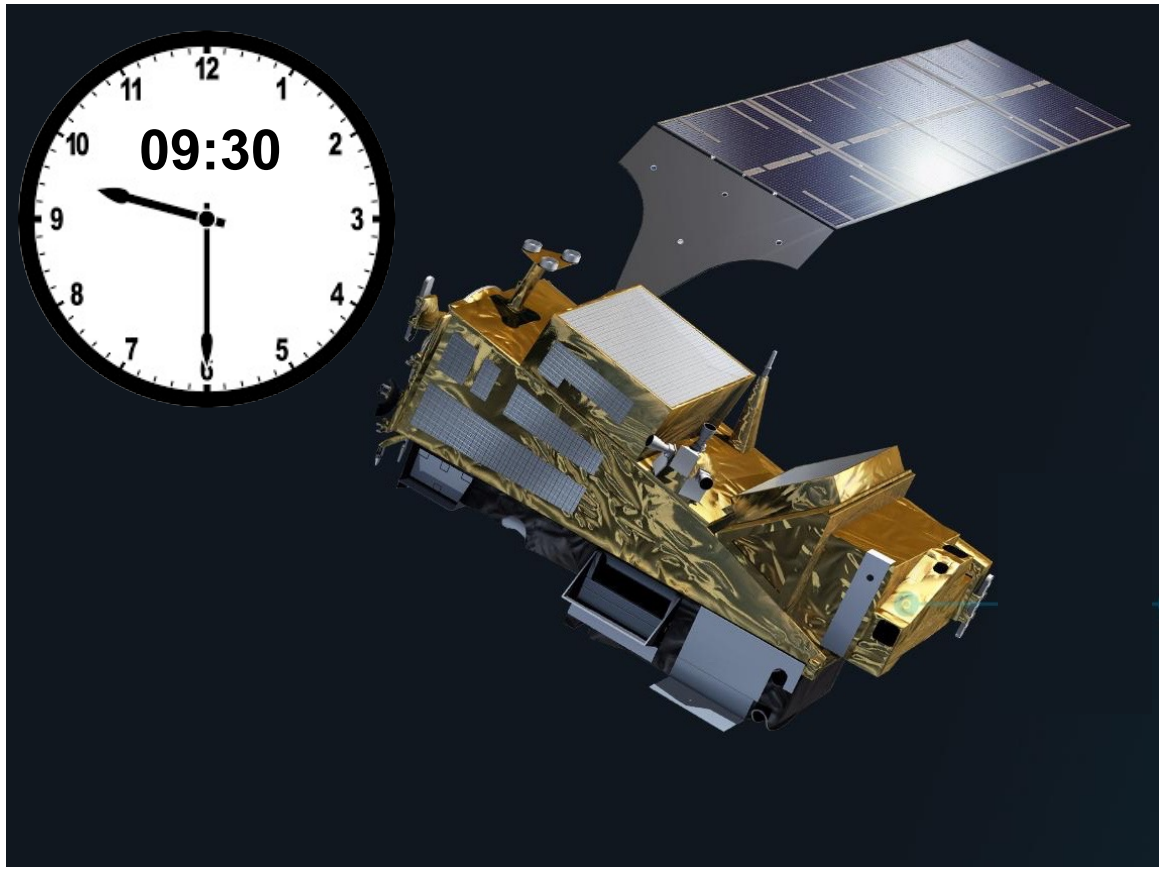
6 May 2021

Instruments in space measuring NH_3 column densities

IASI: Infrared Atmospheric Sounding Interferometer



Resolution: 12 km at nadir

Swath width: 2200 km

Launch date: October 2006

Years used: 2008-2018

CrIS: Cross-track Infrared Sounder

Resolution: 14 km at nadir

Swath width: 2200 km

Launch date: October 2011

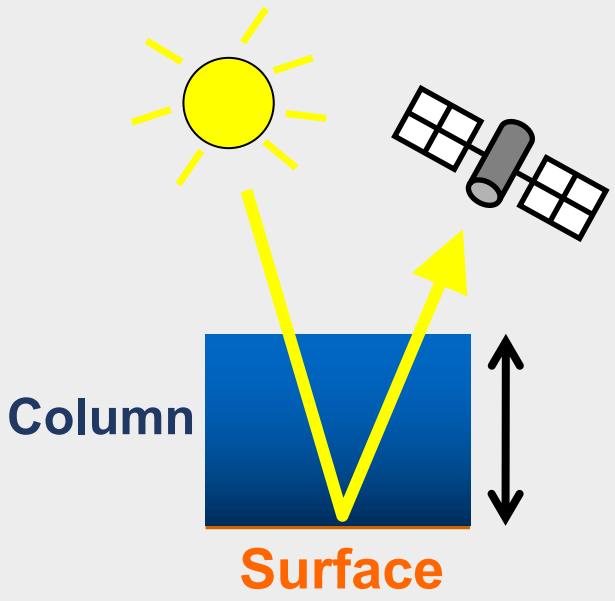
Years used: 2013-2018

Top-down emissions estimated with satellite observations

Convert atmospheric **column concentrations** to surface **emissions** by relating the two with a **model**

COLUMNS → **Conversion Factor** → **EMISSIONS**

Satellite columns

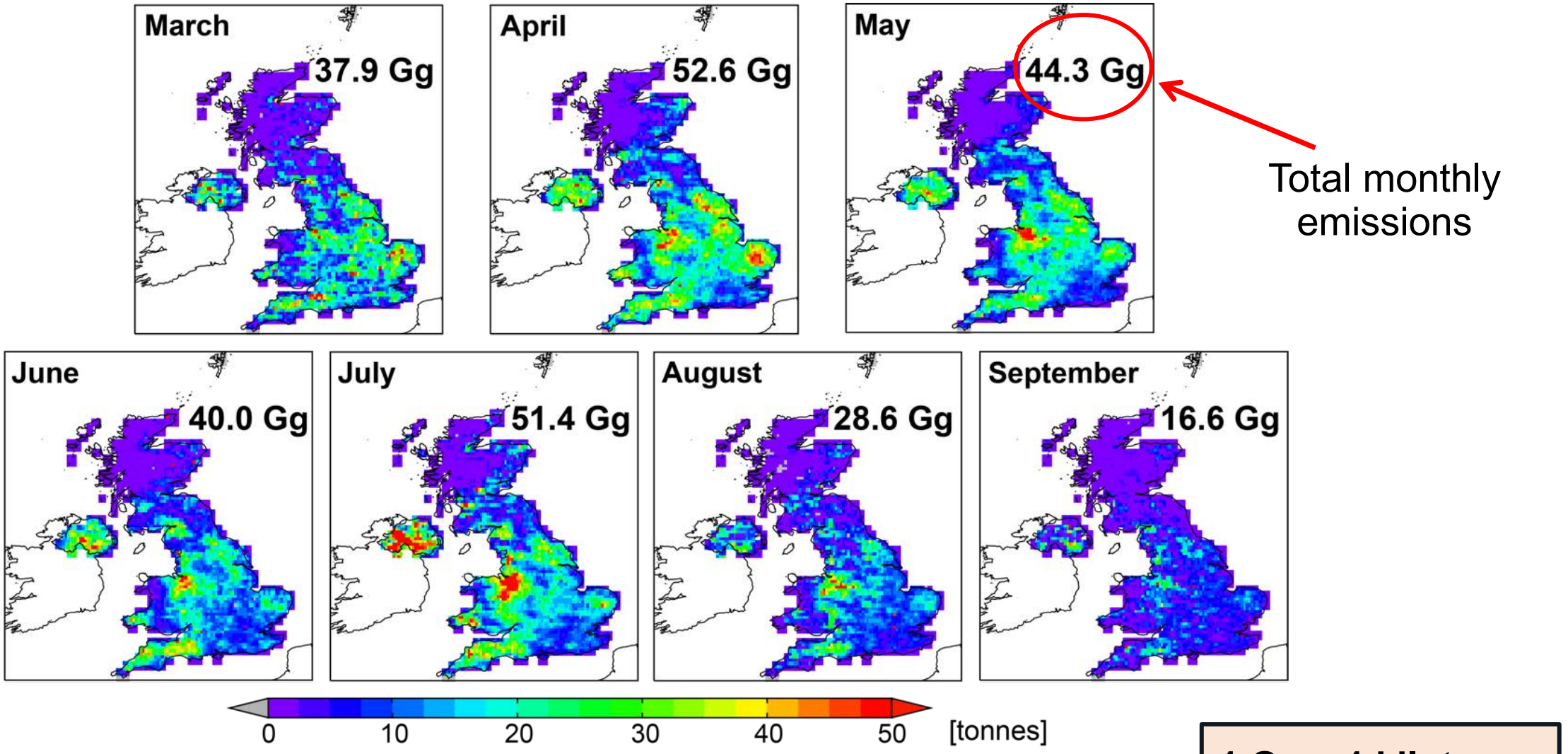


Column-to-Emission ratio (GEOS-Chem)

Satellite-derived Surface Emissions

Emission

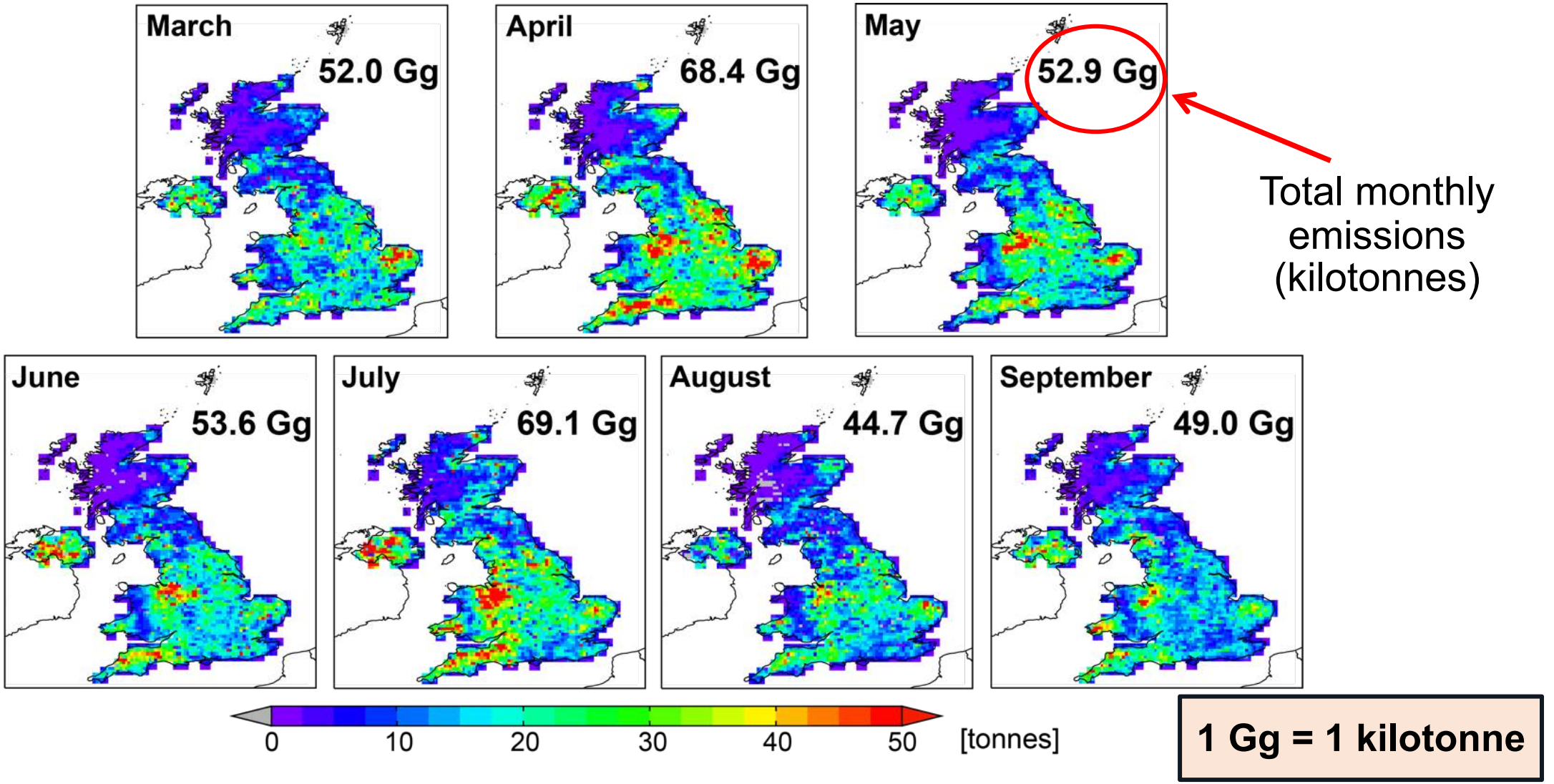
IASI-derived multiyear (2008-2018) monthly mean NH_3 emissions



1 Gg = 1 kilotonne

Monthly emissions for March-September from **IASI**-derived estimates sum to **271.5 Gg**

CrIS-derived multiyear (2008-2018) monthly mean NH_3 emissions

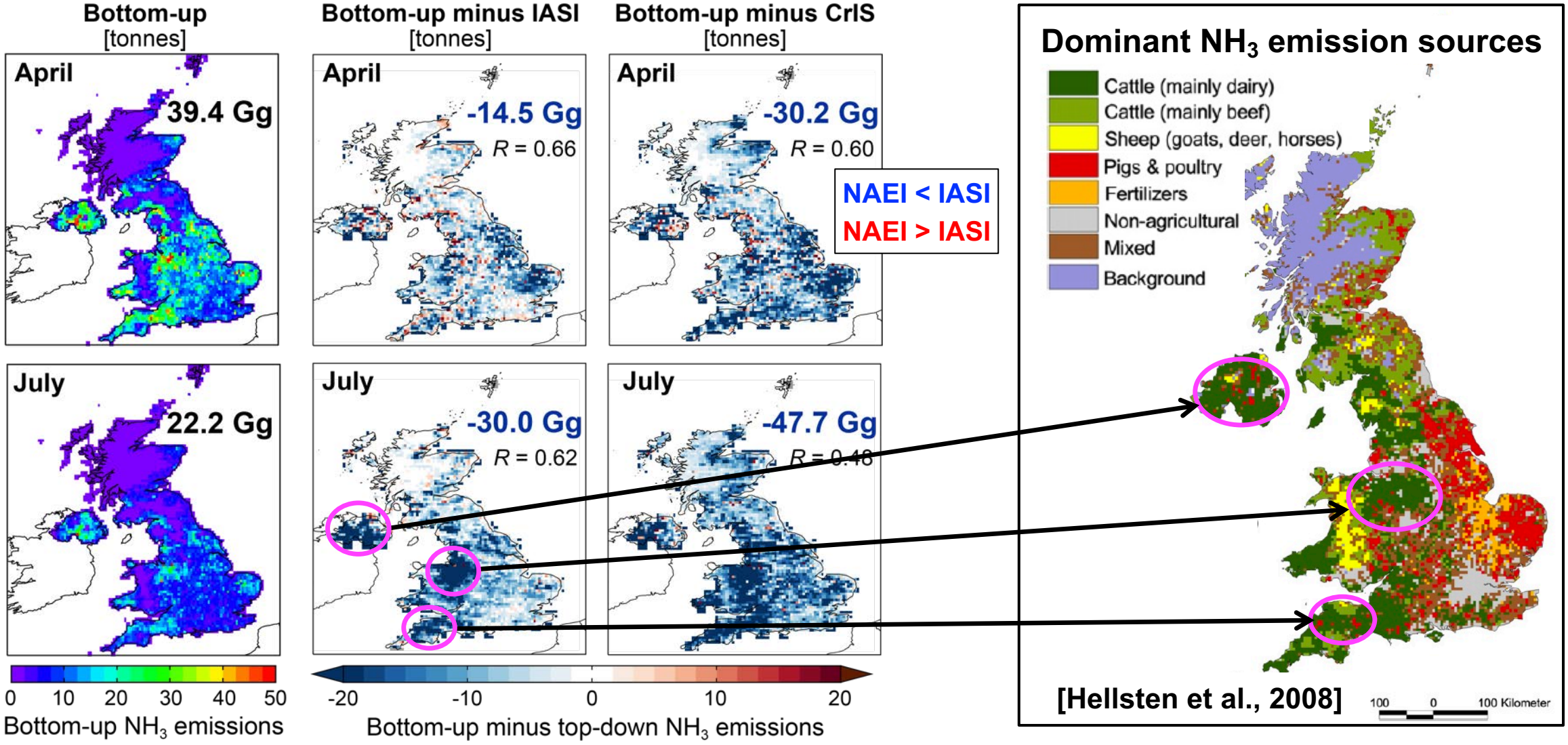


Monthly emissions for March-September from **CrIS**-derived estimates sum to **389.6 Gg**

CrIS is 43% more than IASI. Largest difference of >a factor of 2 in September.

Satellite vs inventory NH_3 emissions: spatial distribution

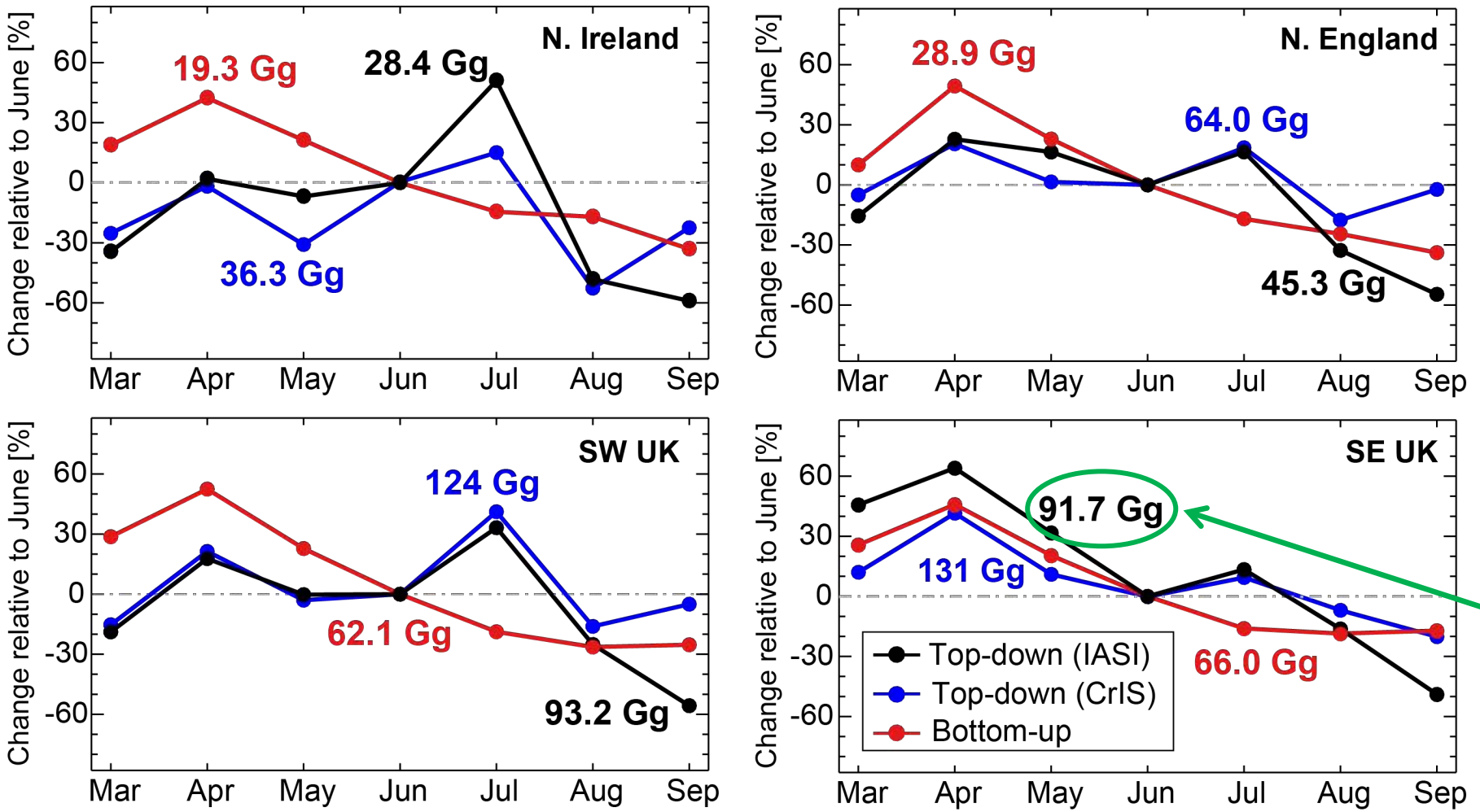
Comparison of months with peak emissions according to IASI and CrIS (April and July)



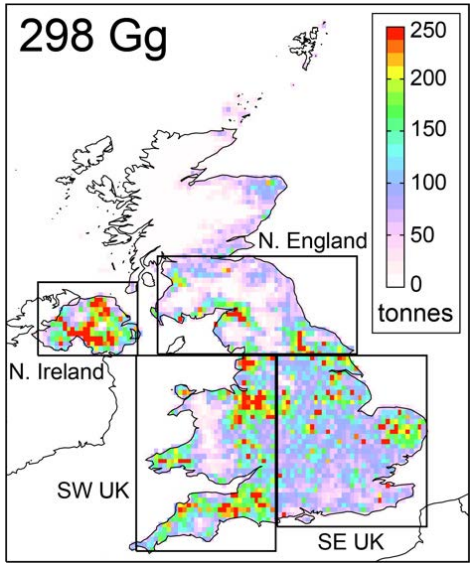
Large July difference over locations dominated by dairy cattle. Inventory is 27-49% less than the satellite values.

Satellite vs inventory NH_3 emissions: seasonality

Seasonality shown as emissions in each month relative to June



Regions and annual inventory emissions



Mar-Sep emission totals in each region

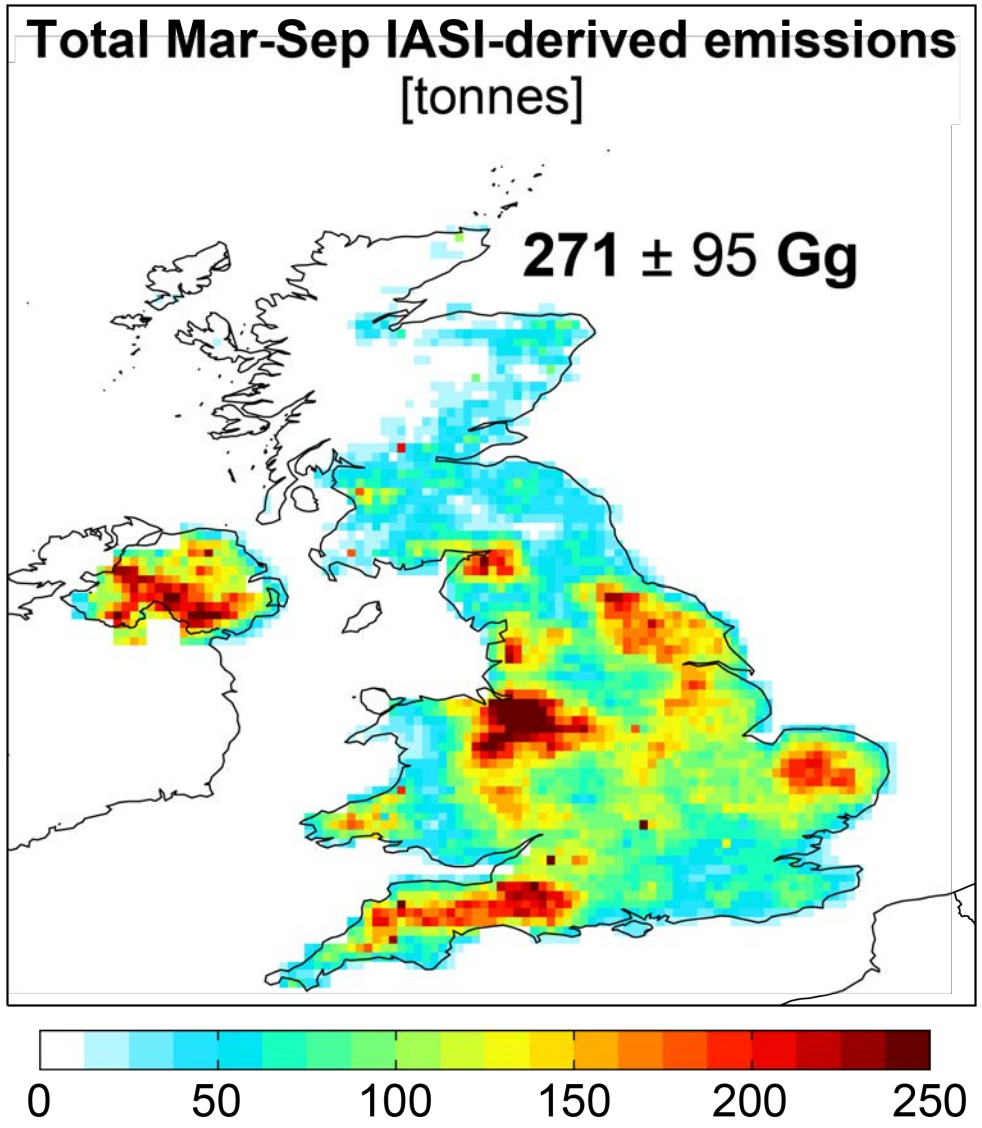
1 Gg = 1 kilotonne

All reproduce spring April peak (fertilizer & manure use). Only the satellite show summer July peak (dairy cattle?).

The increase in emissions in September in CrIS is spurious.

Concluding Remarks

- Inventory estimate of NH_3 emissions are 27-49% less than emissions derived with Earth observations and GEOS-Chem.
- Errors in the satellite-derived emissions are 9-36% for IASI and 8-26% from CrIS, dominated by retrieval uncertainty.
- Largest differences between both top-down estimates and the bottom-up inventory is in July in locations dominated by dairy cattle farms.
- Difference between top-down and bottom-up estimates is corroborated by the UK network of surface concentrations of NH_3
- Warrants further research to resolve discrepancies between the two approaches, as inventories are vital for informing policies



Interested in using the satellite-derived NH_3 emissions in your own work? Email e.marais@ucl.ac.uk